

Defense

The U.S. Department of Defense (DOD) is the nation's single largest energy user, and one of the largest energy consumers in the world. DOD uses enough electricity to power 2.6 million average American homes, and its average daily oil use is over 12,000,000 gallons. Total annual DOD energy costs are nearly \$17 billion per year.



NREL is working with the Marine Corps Air Station Miramar in San Diego, California, to develop a microgrid that is powered by solar, landfill gas, natural gas, and diesel fuel.

Energy supply is a critical mission enabler. But it is also expensive and can increase mission risk:

- Resources spent on energy mean fewer resources for operational readiness, and energy costs are hard to predict and manage
- Operations in theater primarily depend on liquid fuel, which creates supply lines that are vulnerable to attack as well as diversion of assets to maintain and protect them
- Installations typically rely on the civilian electric grid, making them prone to extended outages and power quality issues.

Our Capabilities

NREL develops and applies technologies, data, tools, and analysis to meet operational and installation energy needs. Our expert staff and

facilities are available to support defense programs with efficient, resilient, comprehensive, and affordable energy solutions. Working in partnership with DOD, NREL applies its expertise and capabilities to develop and demonstrate energy technologies at speed and scale, while supporting national security. NREL can also team with DOD laboratories to leverage NREL and DOE knowledge and provide more effective, efficient use of national resources.

Minimize Fuel Consumption, Maximize Resiliency

Operational energy accounts for 70% of DOD's total energy use. Most of this energy comes from liquid fuel used to transport, train, and sustain personnel and weapons.

NREL is working to reduce fuel logistics to decrease operational vulnerability, extend operational reach, enable silent watch, reduce casualties, reduce the amount of combat power diverted from primary missions to protect supply lines, and reduce the assets required for fueling. We partnered with the U.S. Army to complete development and testing of the Consolidated Utility Base Energy (CUBE) System— a power distribution and control device that delivers power from solar, battery, and diesel generators to loads in a forward operating base environment.

With the ability to operate in grid-connected and islanded mode, the CUBE is an integrated hybrid power electronic platform that incorporates:

- Two 30-kW tactical quiet generators
- Solar simulator
- Battery storage system
- Detailed load profiles
- Advanced controls.

The CUBE manages supplies, loads, and storage to meet user needs while minimizing the need to burn diesel fuel. Tests at NREL's Energy Systems Integration Facility (ESIF) have shown a 31% fuel savings, relative to optimally paralleled generators alone, when operating the CUBE in peak-shaving mode. Further fuel savings could be achieved if the system is optimized around bulk power.

Optimizing and Diversifying Power

With more electronic equipment and energy-intensive weapons

systems, next-generation platforms will need more energy. NREL's work in energy efficiency and energy management can reduce fuel use and extend time between refueling.

For example, NREL is working with the Office of the Secretary of Defense, the Navy, and the Department of Transportation to use Maritime Academy training ships to test promising energy saving technologies and increase steaming days between refuelings. The Maritime Pre-Screening Assessment of Conservation Technologies (M-PACT) project uses a ship-board test-bed with sophisticated sensors and a calibrated model to evaluate new and emerging commercial energy efficiency technologies that could be used on combat ships.

For autonomous platforms and dismounted troops, NREL is developing advanced materials that can provide on-site power with reduced weight, size, and cost. For example, NREL is working on advances in photovoltaic materials and manufacturing approaches to achieve high specific power and efficiencies at reduced costs for use in UAVs and dismounted operations.

In addition, NREL is working with DOD staff at Aberdeen Proving Grounds to address issues of reliability and standards for photovoltaics for expeditionary energy.

Increasing Resilience, Decreasing Costs

The frequency of grid outages has increased significantly over the past 15 years; consequently, so have the outages at military installations. Critical DOD missions require a secure supply of high-quality power, which stand-by diesel generators are no longer able to adequately meet. To meet this urgent and growing need, microgrids offer a safe and energy-efficient solution. NREL is developing resilient power systems for fixed installations to:

- Maintain critical loads and combat-support functions
- Minimize energy demand
- Power mission critical loads in an outage
- Utilize diverse energy supplies to secure and extend operations during a sustained power outage.

Using the Continuously Optimized Reliable Energy (CORE) process, NREL is supporting the Marines in developing a microgrid for the Marine Corps Air Station (MCAS) Miramar in San Diego, California, which includes diverse energy sources such as solar, landfill gas,

natural gas, and diesel fuel networked together by an intelligent controller to provide continuous and independent electricity. NREL also supported an Environmental Security Technology Certification Program (ESTCP) demonstration of a flow battery/solar power system at Miramar that included:

- Evaluating several configurations, scenarios, equipment ratings, and other elements of a simulated microgrid at NREL's Energy Systems Integration Facility (ESIF)
- Reducing risk at ESIF prior to on-site testing at Miramar
- Identifying and resolving issues that would have caused disruptions and would be difficult to fix in the field.

This demonstration project was selected as the ESTCP Project of the Year for FY16.

NREL has also provided evaluations of energy efficiency, generation, and resiliency at Air Force, Marine, Navy, and Army facilities throughout the world using sophisticated optimization and modeling tools.

Contact Us

NREL's collaboration with the Office of the Secretary of Defense and the military services helps DOD achieve key energy security goals, while setting the stage for broad market adoption of these technologies. For more information, contact NREL's Director of DOD Energy Programs Steve Gorin (<mailto:stephen.gorin@nrel.gov?subject=>).